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DESIGN OPERATING MANUAL FOR HEAVY OIL MINIPLANT

CANMET RESEARCH CENTRE
DEVON, ALBERTA

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MICROMEDIA

Introduction

The Coal Research Laboratory of the Canada Centre for Mineral and Energy Technology (CANMET), Energy, Mines & Resources Canada (EMR) is involved in research and development related to the treatment of oil-in-water, water-in-oil emulsions and effluent waters produced from the in-situ recovery of tar sands and enhanced recovery of heavy oils.

The experiments carried out at 70 bpd Mini plant includes oil-water separation equipment such as Free Water Knockout (FWKO), Dual Polarity Electrostatic Treater (DPET), Evaporation, Dehydration, Induced Gas Flotation, etc., arranged in a manner allowing maximum flowsheet flexibility and comprehensive sampling for material balance.

The Manual will assist operating personnel and Scientists in everyday work. Operating parameters and equipment specifications are also provided. The Manual discusses safety aspects and includes commissioning and start-up instructions.

While no attempt is being made to cover all safety aspects in the plant, it is appropriate to mention those hazards that will be encountered most frequently by Mini Plant personnel.

The Heavy Oil mini plant testing/research facilities are located in Devon, Alberta.

Basis of Design

1.0 Physical Requirements

Mini Plants process equipment is installed in existing warehouse building provided with upgraded heating and ventilating systems.

2.0 Process Requirements

2.1 Feedstock Fluid

- Heavy Oil and Tar Sands emulsion as is produced by Thermal recovery method.

2.2 Produced Fluids

a. Bitumen

b. Produced Water

c. Produced gas

d. Diluent

3.0 Utility - (From Canmet existing facility)

a.	Natural Gas	N/A
b.	Electric Power	225 KVA - 600, 480V
c.	Instrument Air	20psig, 10 scfm, -20°F Dew Point
d.	Service Air	100psig, 30 scfm
e.	Steam	100psig, 300 lbs/hr,

4.0 Major Equipment

Tanks

T-1- Heavy Oil Feed Tank	4'0" Dia.x 8'0" A 750 USG
T-2- Produced Oil Storage Tank	4'0" Dia.x 8'0" A 750 USG
T-3- Produced Water Tank	3'0" Dia.x 5'0" H 210 USG
T-4- Diluent Tank	2'6" Dia.x 4'0" H 150 USG
T-5- Demulsifier Tank	2'6" Dia.x 4'0" H 150 USG

Pumps

P-1	Feed Pump	
P-2	Off Spec. Produced HO Recycle pump	
P-3	Off Spec. P.W. recycle pump	
P-4	Diluent Injection Pump	20 GPH
P-5	Demulsifier Injection Pump	1.2 GPH
P-6	Transfer Pump (Pneumatic)	2.3 GPM
P-7	Produced Fluid Transfer Pump (Variable Speed)	
P-8	Produced off spec. oil Transfer Pump (1 HP)	

Special

V-1	Free Water K.O. Drums	30" Dia.x 6'0" S/S
V-2	Electrostatic Treater	48" Dia.x 6'0" H
V-3	Heavy Oil Evaporator	54" Dia.x 7'0" S/S
V-4	IGF depurator	
V-5	Vertical Liquid Accumulator	6 5/8" Dia.x 2'6" S/S
V-6	Vertical Skimmer Vessel	6 5/8" Dia.x 5'0" S/S
F-1	Feed Filter	6" Dia.x 4½" H

X-1	Static Mixer	1½" Dia.
HT-1	Chromolox heater	3 x 20 kw
P-9	Produced water transfer pump (¼ HP)	
HT-2	Off spec produced fluid heater (L.P. steam)	56 kw
HT-3	Cooler (Fan 3 HP)	
HT-4	Immersion Heater	48 kw

Piping Line List

- 2" FO-001
  1" FO-005
  1" FO-006
  1" PO-001
  1" PO-002
  1" PO-004
  1" PO-006
  1" PO-003

  3"-VG 002
  1"-VG 006
  1"-VG 003
  3"-VG 007
  3"-VG 004
  1"-VG 001

  1"-PW 001
  1"-PW 002
  1"-PW 006
  1"-PW 007

  2"-SL 002
  2"-SC 002

  3/4"-C1-002
  3/4"-C1-004
  1"-P0-009

5.0 List of Motors in the Heavy Oil Mini-Plant

EQUIPMENT	TAG	HORSE POWER	VOLTS	AMPS	FREQUENCY	RPM
Pump	P8	1 HP	208-230/460	3.6-3.4/1.7	60 Hz,3ph	1725
Pump	P3	¼Hp	115/230	5.4/2.7	60 Hz,1ph	1725
Air-X-chg.	V-3	3Hp	230/460	9.06/4.53	60 Hz,3ph	1155
Pump	P2	3Hp	230/460	8.63/4.31	60 Hz,3ph	1800
Chromalox Heaters	H2	20 KW	460V	-	-	-
Pump Mech. Var. Speed	P7	½Hp	208-230/460	2.5-2.4/1.2	60 Hz,3ph	1140
Transformer		2kVA	480	-	-	-
Chromalox Heaters	H3	3x20 KW	480	-	3ph	-
IGF Unit (Agitator)	V4	4X3/4Hp	230/460	2.4/1.2	60/50,3ph	1725/1425
IGF Unit Skimmer	V4	1/3Hp	230/460	1.44/.72	60.3ph	1725
Pump	P9	¼Hp	115/230	5/2.5	60,1ph	1725
Pump	P1	3Hp	230/460	8.64/4.31	60,3ph	1800
Chromalox Heater	H1	48kW	460	-	3ph	-
Mixer	M1	1.5Hp	230/460	4.6/2.3	60,3ph	1720
Pumps	P4&5	2X¼Hp	115/230	5.6/2.8	60,1ph	1725
Building Exhaust Fans		2X0.75	-	-	60,1ph	
Make-up		7.5 HP	-	-	3 ph	
Air Unit		7.5 HP	-	-	3 ph	
Make-up Air Unit		7.5	-	-	3 ph	

6.0 Codes and Standards

The facilities are designed and constructed in accordance with all the latest revisions of governing national, provincial and local codes and standards.

C. Discussion of Design

1.0 Overview

Edmonton Coal Research Laboratory of CANMET is involved in R & D related to the treatment of oil-in-water, water-in-oil emulsions and effluent waters produced from in-situ recovery of tar sands and enhanced recovery of heavy oils.

The work is carried out at various scales of experiments including a proposed 70 bpd mini-plant. Its scope is unique and covers the entire spectrum of the treatment of mixed emulsion (thermally recovered oil-in-water and water-in-oil), the produced heavy oil and produced water. It will include oil-water separation equipment, such as free water knockout, dual polarity electrostatic treater, evaporation dehydrator, induced gas flotation, etc., arranged in a manner allowing maximum flexibility and comprehensive sampling for material balance.

Heavy oil mini-plant with its flexibility in implementing flowsheet options and close monitoring of process variables will be ideally suited to solve oil-water, water-oil emulsions separation problems.

The mini-plant objectives are to:

a) design and optimize different process/flowsheets;
b) evaluate and improve oil/water, water/oil emulsion separation processes;
c) test and evaluate new process monitoring and control equipment.

It will enable the researcher to:

a) determine the set of parameters that governs oil/water separation, which can also be extrapolated to or dimensional-analyzed for a larger industrial plant,

b) evaluate, in conjunction with controllability of the process configuration and as well as the performance of the pre-selected major pieces of separation equipment.

To achieve the above ultimate objectives, our design basis has been developed to emphasize Maximum Experimentability. Our proposed Heavy Oil Mini-Plant will:

- provide maximum flexibility of processing oil-in-water (water-rich) and water-in-oil (oil-rich) feeds and the recycled streams for expanded experimentation,

- yield reproducible parametric data or process and control variables utilizing computer processor and,

- enable components and material balance associated with the process streams to be elucidated.

Maximum experimentability is in fact a result of optimization, taking priorities, physical constraints and equipment limitations into consideration. This treatment of produced fluids is a separation process concerned with demulsification and subsequent oil-water interfacial and interphase mass transfer. It deals with thermal fluid dynamics involving liquid droplets and gas bubbles in a continuous medium.

The proposed project covers the whole spectrum of produced fluids treatment:

- feed (emulsified fluid) demulsification
- separation of oil from oil-in-water (water-rich)
- separation of water from water-in-oil (oil-rich)

In the process of separation, the basic solids are also removed from the continuous phase. However, the raw produced fluids from thermal recovery wells generally contain such impurities as dissolved solids, suspended solids, silica, solvated chemical complexes, metallic and ionic matters in water and others. It should be understood that not all the impurities will be removed as basic solids. (For instance, significant reduction in silica content can only be achieved by hot lime softening).

Separation mechanisms for the four pre-selected pieces of equipment can be briefly described as:

FWKO: momentum change and density gradient promoted coalescence and phase separation;

DPET: high electrostatic frequency generated bubble adsorption and coalescence, assisted by demulsifier and/or diluent, with heavy oil itself being the continuous medium and settling water droplets being the heavy phase;

EVAPORATOR: thermally induced evaporative separation of low fugacity components, i.e., water and light hydrocarbons.

IGF: gas bubbles interfacial adsorption/froth flotation assisted by demulsifier with water being the stable, continuous phase;

It can be shown, symbolically, there exists a qualitative functional relationship:

$S = f\{I, D, Vs, dl, dg\}$

in which
- S = degree of separation
- I = oil/water interfacial strength
- D = density gradiant across interface (approximated to density difference between produced water and produced heavy oil)
- Vs = viscosity of continuous medium (either water or heavy oil)
- dl = "size" (or approximately diameter) of settling droplets
- dg = "size" of rising bubbles.

The "." affixed to the parameters in the right hand side of the equation indicates:

S proportional to the parameters D and d1
S reciprocally proportional to I, Vs and dg

The heavy oil/water interface strength, which is related to interfacial tension, can be reduced, within the context of this project scope, by effective mixing, higher temperature, adding demulsifier and adding condensate/diluent. Raising the operating temperature and addition of demulsifier are the two predominant methods to reduce oil/water interfacial strength.

Effects of D, Vs, d1 and dg on separation have been tackled quite extensively in the past.

All and every functional parameter that affects separation efficiency for a fixed emulsion feed of definite physio chemical characteristics depends on two primary manipulated design variables:

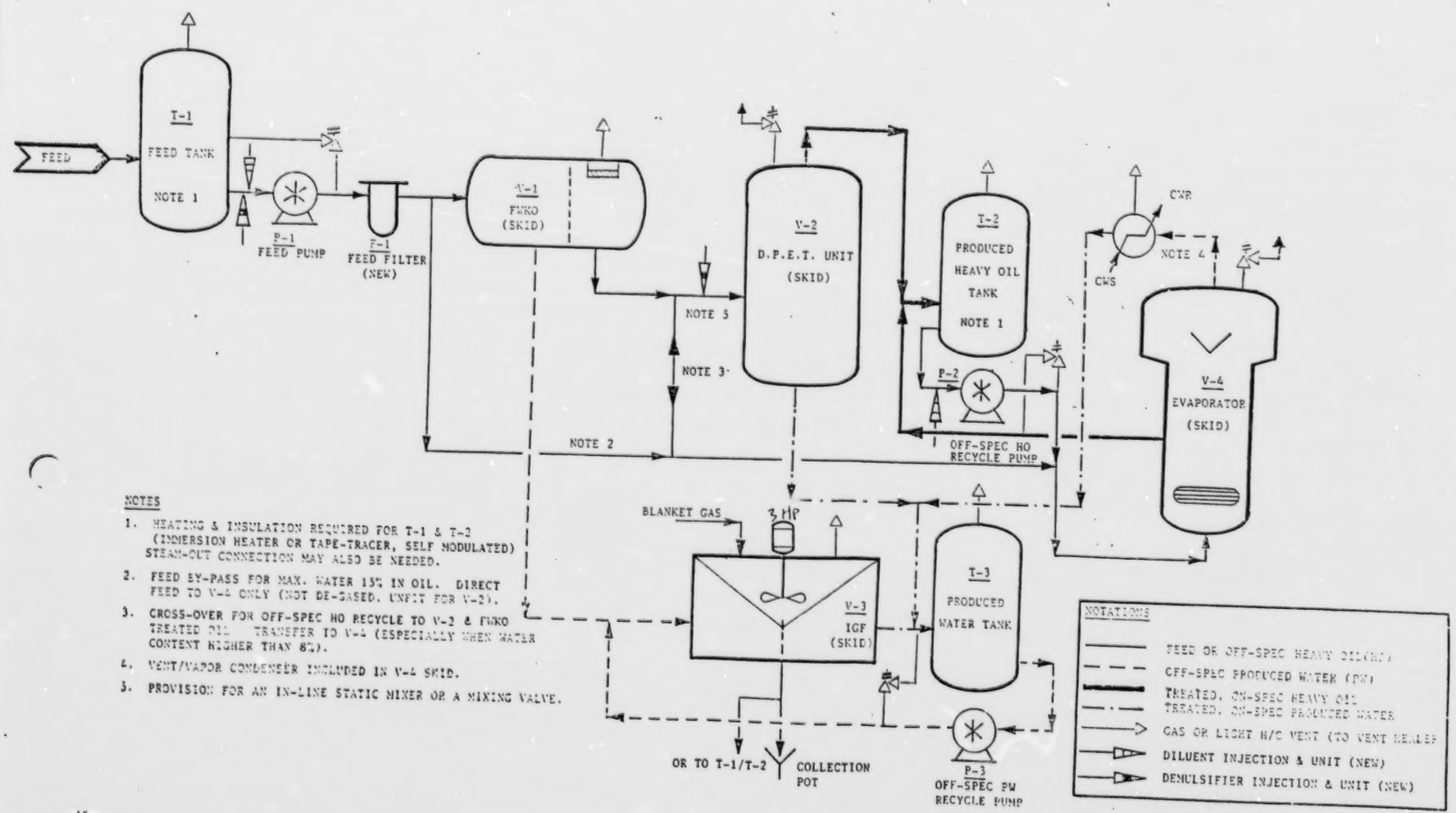
- temperature of fluids
- addition of demulsifier

and to a lesser extent on two secondary variables:

- addition of diluent
- mixing, vibrational frequency (DPET), velocity, etc.

HEAVY OIL MINI-PLANT SCHEMATIC DIAGRAM

DSS FILE NO. 09SQ. 23440-3-9118



NOTES

1. HEATING & INSULATION REQUIRED FOR T-1 & T-2 (IMMERSION HEATER OR TAPE-TRACER, SELF MODULATED) STEAM-OUT CONNECTION MAY ALSO BE NEEDED.
2. FEED BY-PASS FOR MAX. WATER 15% IN OIL. DIRECT FEED TO V-4 ONLY (NOT DE-GASED, UNFIT FOR V-2).
3. CROSS-OVER FOR OFF-SPEC HO RECYCLE TO V-2 & FWKO TREATED OIL TRANSFER TO V-4 (ESPECIALLY WHEN WATER CONTENT HIGHER THAN 8%).
4. VENT/VAPOR CONDENSER INCLUDED IN V-4 SKID.
5. PROVISION FOR AN IN-LINE STATIC MIXER OR A MIXING VALVE.

2.0 Process/Flow Description

2.1 Feed Systems

The virgin produced fluid feedstock which is contained in oil barrels is transferred to Heavy Oil Feed Tank (T-1) by the Portable Barrel Transfer pump. The Transfer Pump is pneumatically operated, using compressed plant air. The pump has a capacity of 5 to 25 gpm. Flexible hose connections are provided at pump discharge and feed tank nozzle.

The feed tank, an insulated flat head atmospheric design tank, is equipped with an internal Chromalox Immersion Heater (H-1). The side-mounted electrical heater of 48 kW will preheat the stored feedstock to 150°C in two hours. The mixer, mounted on the top, will facilitate heating, promote homogenous temperature and prevent over heating/coking on sheath surface of the heater. Two relief valves are provided, one for normal vent and breath and the other for emergency discharge to Hydrocarbon Vent Header. The steam-out nozzle can be utilized for internal cleaning, de-oiling or grease-removal. The tank is also equipped with a boot. Accumulation of crud, solids and so on in the boot can be pumped from the bottom.

In addition to the two PSV's, a temperature indicator (T1-080) and a level gauge (LG-096) are installed on the feed tank and a temperature switch (TS-090) on feed heater.

Mixer (M-1) on the Heavy Oil Feed Tank (T-1) is a new replacement for the DSS-supplied counterpart which, in addition to, equipping it with a TEFC motor, was suitable only for side-mounting on vertical tank.

Coming off the bottom of feed tank is the suction line for Feed Pump (P-1), which is supplied by DSS. A feed flow control loop, consisting of flow control valve (FV-001), flow transmitter (FT-001) and flow indicating controller (FIC-001), is installed on the main feed line. A minimum flow line (1"-FO-004-A) connecting pump discharge and feed line to feed tank will serve to protect Feed Pump and, as well, to facilitate establishing a steady desired feed flow in the initial start-up period.

A pressure indicator (PI-060) and PH meter (PH-094, CANMET supplied) are also installed on the main feed line. In addition, a Feed Filter (F-1) capable of retaining particles of 5 microns and larger is designed to protect the downstream mass flowmeter. It also serves to give a clean, more uniform feed for the treatment equipment. Due to filtration function, diluent and demulsifier injected upstream of the filter will be thoroughly mixed, avoiding stratification.

The pump discharge flow can be fed directly to the primary separator, the Free Water Knockout Drum (V-1 FWKO), or bypassed to either of the downstream secondary separators, namely Dual Polarity Electrostatic Treater (V-2 DPET) and Evaporator (V-3). However, precautions must be taken in bypassing the feed flow, as stated later.

2.2 Primary Separation by FWKO

Produced fluid that contains more than 15% of water is fed directly to FWKO. Operating temperature is set by feed tank heater H-1 and operating pressure set by feed pump P-1. Flowrate is measured and transmitted by FQI/FI-003.

Separation by FWKO yields three product streams: Gas, Produced Heavy Oil and Produced Water. Of the three product flowmeters, only the latter two will be converted and flowrates transmitted (loops FQT 004 and FQT 005) to central processor. The emerging product gas is vented through a pressure control valve to the H/C Vent Header. The Produced Water which should contain oil in the range of 1% to 10 ppm, depending on feed composition, is fed directly to Induced Gas Flotation Unit (IGF, V-4) for final oil removal. The Produced Heavy Oil can be fed either to DPET via line 1"-PO-001-A or to Evaporator via lines 1"-PO-004-A and 1"-PO-008-A.

Density of the Primary Produced Heavy Oil is measured with data transmitted to computer by DT-093 and DI-093. A low point drain for FWKO is provided on line 1"-PW-001-A.

2.3 D.P.E.T. (V-2) - Secondary Treatment for Produced Heavy Oil

The Primary-treated Produced Oil from FWKO can be fed to DPET, via line 1"-PO-001-A. The incoming oil is degassed in FWKO and contains generally less than 12% water.

Before entering the skid, demulsifier and/or diluent are injected into the oil. To facilitate mixing of injected fluids and the produced oil, a Static Mixer (X-1) is installed. The Static Mixer has no moving parts. Mechanical maintenance is therefore not required.

The thoroughly mixed fluids enter DPET at suction side of the Moyno Pump. Chromalox Heaters will provide heating needed to raise the temperature for desired operations. Operating temperature and pressure are measured at the treatment vessel and are transmitted to computer by TI-043 and PI-021.

The flow of produced heavy oil, which emerges at the top of DPET Vessel, is measured by FQI-006 with data transmitted by FI-006. The oil is expected to contain less than 0.5% BS & W. The produced water is letdown via level control valve, LV-095 and is routed to Produced Water Tank (T-3), via line 1"-PW-006-A. Produced water flow is measured and transmitted by FQI/FI loop 007.

A drain connection, at Tie-point 36, is provided for Chromalox Heaters and the main vessel.

2.4 Evaporator (V-3) - Secondary Treatment for Produced Heavy Oil

The primary treated produced oil from FWKO can also be further processed by thermal evaporator. Instead of taking off to DPET via line 1"-PO-001-A, the produced oil is channelled via 1"-PO-004-A and 1"-PO-008-A to Evaporator.

The feed stream comes into the skid is pre-heated by a steam-heated exchanger before entering the evaporation, horizontal vessel. The vessel is equipped with steam coil which acts as the heat source for evaporating water and light hydrocarbons. Evaporation takes place in the heavy oil-water interface in essentially a quiescent manner. The de-watered produced heavy oil exiting from the bottom is pumped through an aerial cooler then to Produced Oil Storage Tank (T-2). The evaporated vapor mixture, on the other hand, emerges from the top of vessel and is condensed in an aerial cooler before entering a surge vessel. The accumulated liquid mixture is then pumped to a vertical two-phase liquid separator in which light hydrocarbons are separated from water. The Produced water at the bottom is continually letdown via a level control valve (LV-602) to Produced Water Tank (T-3). The light ends fraction is letdown by another level control valve (LV-601) and recovered in a collection pot for possible re-use as diluent.

The recovered diluent stated above may not contain the same constituents as originally injected. Further, depending on separation efficiency, it may be contaminated. Returning directly to Diluent Tank (T-4) is therefore felt not appropriate.

Again operating pressure, temperature and flowrates of recovered diluent, produced water and produced oil are measured and transmitted to computer data management unit.

A floor sump drainage connection is also provided for evaporation vessel. All vents are tied to the new H/C vent header.

2.5 Induced Gas Floatation Unit (V-4) - Secondary Treatment for Produced Water

The Induced Gas Flotation unit provided, at the present project scope, the final treatment for de-oiling produced water.

The main feed source for IGF is the primary treated produced water from FWKO (via line 1"-PW-001-A). It can also take the recycle stream from Produced Water Tank (T-3), via Pump (P-3). Mixing of both streams in a single feed is also possible too.

I.G.F. by denotation is operated by pressurized natural gas (or nitrogen or other inerts). As the IGF is operating on plant air supply, and under normal operation, a certain amount of degessing occurs in the IGF, the concentration of hydrocarbon gas will increase proportionally to the amount of time that the IGF is in operation. It is strongly recommended that either:

1. Nitrogen be used instead of air
2. If air is to be used, constant monitoring of the gas phase in the unit must be done so that the induced gases hydrocarbon content remains within the non-explosive range.

For the present case, it is to be air-floated, using building/plant air supply. The plant air is letdown by a pressure control valve (PCV-950). Operation using natural gas is NOT allowed, as this would require major piping modifications on the breather valve on the skid.

The final treated produced water which, depending on feed condition, is expected to contain less than 10 ppm of oil and therefore is drained directly to floor sump. The skimmed oil/oil froth will drip down to a collection pot for disposal.

Sampling is provided. The feed flow is also measured, with capability of data transmission, by a magnetic meter (FT-002).

A future flanged-end connection is provided at the product end, on line 2"-PW-003-A.

2.6 Bypass and Recycle Operations

The design is built-in with the flexibility of both operations.

In the bypass mode, raw produced fluid feed containing less than 15% of water can be fed directly to either DPET or Evaporator or both simultaneously. This is done via the bypass lines:

- 1"-FO-006-A; main bypass line
- 1"-PO-001-A; to DPET
- 1"-PO-00X-A and 1"-PO-008-A; to Evaporator

The treated produced water from either skid or both can be concurrently fed to IGF by Pump P-3.

In the recycle mode, the "off-spec" produced heavy oil from tank T-2 is pumped by recycle pump P-2 to either Evaporator or DEPT or both simultaneously for further treating. Again IGF can be called up for the produced water treatment at the same time. Feed flow is measured and transmitted by flow control loop 002, consisting of a Turbine Meter (FT-013), Flow Control Valve (FV-002), Controller (FIC-002).

2.7 Rheological Test Loop (RTL)

Four RTL's are designed:

- RTL No. 1 on the main Produced Fluid Feed Line (1"-FO-003-A)
- RTL No. 2 on the main primary treated produced oil line (1"-PO-001-A)
- RTL No. 3 on the main recycle/off-spec produced heavy oil line (1"-PO-004-A)
- RTL No. 4 on the final treated produced heavy oil line (1"-PO-002-A)

Hence all the fluids of major concern will be subject to rheological test.

The RTL consists of a Pressure Differential Transmitter (PDT-020) which measures pressure drop across the loops, a Temperature Element and Indicating Transmitter (TE/TI-042) and the U-shape piping of approximately 40' or more (min. L/D = 650). The loop is insulated and ended with flexible hose connections (Quick Couplings). Proper valving is included for operation.

2.8 Demulsifier and Diluent Injections

Either injection system has an essentially identical configuration:

- a storage tank, T-4 for Diluent and T-5 for Demulsifier
- an injection pump, P-4 for Diluent and P-5 for Demulsifier
- A flow control and measurement/transmitting loop, FQ/FI/FT-011 for Diluent and loop 012 for Demulsifier.

The injection pump, a diaphragm type, is equipped with a pneumatic stroke counter, internal fluid recycle and relief. Explosion proof motors are used in both cases. At pump discharge header, hard-piped three-branches are built. Each branch line is ended with a quick connect for flexible hose connection to specific injection point at the process location.

3.0 Electrical System

3.1 Electrical Power Distribution

Electrical power is supplied from 225 kVA-600.480V transformer located in the "Maintenance Bldg." Motor Control Centre. Square "D" Model 4 is located in the MCC room inside the Maintenance bldg.

3.2 Emergency Power NOT PROVIDED.

4.0 Fuel Gas

N/A to the process facility.

5.0 Instrument Air

Instrument and purge air is provided from the Canmet's Research Centre air supply system.

6.0 L.P. Steam

High pressure steam and condensate to/from the evaporator skid is tied into Canmet Steam System.

7.0 Heating and Ventilating

By Kilborn Energy Inc. issued under separate cover.

8.0 Drains and Vents

As indicated on the P & ID.

9.0 Safety/Health Aspects

9.1 Introduction

The information contained in this section is intended to assist operators in establishing and maintaining operating design conditions while operating the plant safely and efficiently.

Note that emphasis is placed on SAFETY, as SAFETY AWARENESS is an essential part of the operation of any plant.

If more detailed information on individual items of control is required, refer to vendor manuals in the job data books or to equipment data sections and instrument specification sheets; these are not included in this manual.

Every attempt is being made to cover the safety aspects in the plant. It is appropriate to mention the usual hazards that may be encountered by plant personnel.

Such hazards are:

- Hydrogen Sulphide (H_2S)
- Chemicals
- Heat
- Sulphur Dioxide (SO_2)

9.2 Hydrogen Sulphide (H_2S)

Although H_2S bearing as has not been considered in the pilot plant design, it is essential that operators be aware that H_2S conditions may occur and must be prepared to handle such an emergency. Since H_2S is a very toxic gas, certain safety measures are required to protect personnel in the event of a gas leakage or an emergency gas release.

Three protective measures are:

- respect for the H_2S
- reaction to the H_2S emergency,
- rescue using protective and detective equipment.

9.2.1 Hazard

H_2S is a highly toxic, colorless gas, heavier than air, with the odor of rotten eggs. It burns with a blue flame and produces Sulphur Dioxide (SO_2), a very irritating gas with a pungent odor.

H_2S forms explosive mixtures with air; the lower explosive limit being 3.4% and the upper explosive limit 46.0%. It is soluble in water (and oil) but becomes less soluble at higher temperatures.

H_2S is generally recognized by a characteristic foul odor. Prolonged exposure, even at low concentrations, will dull the sense of smell, while a breath of higher concentrated H_2S will immediately deaden the olefactory system. This could be fatal to those who think that H_2S is only detected by its offensive odor.

In low concentrations, H_2S irritates the eyes, throat and respiratory system. When higher concentrations are present, even for a very short period of time, death, due to lung paralysis, may occur before the odor is detected.

Toxicity of various concentrations:

1 ppm (.0001%)	Olefactorily detected
10 ppm (.001%)	Maximum allowable concentration for 8 hour exposure
100 ppm (.01%)	Deadens olefactory system 3 - 5 minutes.
200 ppm (.02%)	Deadens smell rapidly, burns eyes and throat.
500 ppm (.05%)	Respiratory disturbances in 2 to 15 seconds. Artificial resuscitation required.
700 ppm (.07%)	Victim rendered unconscious; breathing stops; immediate artificial resuscitation required.
1000 ppm (.1%)	Immediate unconsciousness, permanent brain damage unless rescued promptly.

From the previous information, it is obvious that the wearing of protective breathing equipment is a MUST in ANY H_2S concentration.

9.2.2 Detection & Protection

Of the portable detectors available, two of the most commonly used are:

a) Lead Acetate Paper or Ampoules (qualitative)

b) Air Sampling Gas Detector Tubes (quantitative)

Lead acetate devices only indicate qualitatively the presence of H_2S and are not to be used to measure H_2S concentrations. H_2S detectors and tubes (Draegar, Gastech) are used to quantitate concentrations and are accurate only if the person performing the test is trained in their use.

Breathing protection must be worn whenever H_2S is encountered or suspected to be in an area. A mechanical resuscitator should be made available at the plant. Plant personnel must be trained in the use of breathing equipment, in performing rescues and in First-Aid. Frequent rescue simulations should be carried out to maintain a high standard of rescue expertise.

9.2.3 Rescue

If one finds a person overcome with H_2S, the natural and instinctive reaction is to rush in and help.

Personnel dealing with H_2S must be trained to quickly and accurately analyze the problem and must train themselves to oppose this instinctive action.

9.3 Caustic Soda (NaOH)

9.3.1 Hazard

This material, also called sodium hydroxide, has a very corrosive action on body tissue in both solid and solution form.

Inhalation of dust or concentrated mist can damage the respiratory tract or cause severe irritation.

Caustic soda will react with water to produce heat, will attack tissue and cause severe burns to skin and eyes.

9.3.2 Protection

Wear the following approved fully protective gear when working with caustic soda:

- Chemical gloves
- Neoprene boots (tucked inside of chemical suit)
- Chemical suit
- Chemical hood

When spills occur, ventilate and flush with large amounts of water. Do not step into spilled material; it is very slippery.

Take care when mixing caustic soda to water boiling and puking will occur.

Know proper first aid procedures.

9.3.3 First Aid

START FIRST AID AT ONCE - Speed in removing this material from the body is of prime importance.

Wash material off with plenty of running water; use safety shower. Remove contaminated clothing while under shower.

Shower for at least 15 minutes, longer if possible - DO NOT USE SOAP.

In case of eye contact, wash eyes for at least 15 minutes. If pain persists, remain washing for another 15 minute period. Roll eyes in a circular motion to ensure contact with water with all tissues of eye and lid.

9.4 Sulphur Dioxide (SO_2)

Sulphur Dioxide is a pungent, irritating gas produced in large quantities by the combustion of sulphur or compounds containing sulphur. Since it is water soluble and forms a weak sulphurous acid (H_2SO_3), its action is likely limited to irritation of mucous membranes in the upper respiratory system and skin irritation.

In concentrations of 1-10 ppm, respiratory and pulse rates increase and depth of respiration in unclimatized individuals decreases. Acclimatized individuals, working daily in

concentrations in excess of 10 ppm, may not show these changes on exposure.

Severe exposures to SO_2 may result when loading tanks cars/trucks or from leaking lines. Personnel should wear proper eye, respiratory, skin, and mucous membrane protection.

It is highly irritating to the eyes, nose, throat and lungs in concentrations greater than 20 ppm.

Sulphur Dioxide deserves the same respect as H_2S and should always be treated accordingly.

9.5 Chemicals (General)

Certain chemicals are used throughout the plant. As some chemicals are more hazardous than others, only the altter are discussed in detail. Although the other chemicals are not termed "hazardous", their respect is warranted.

Refer to vendor catalogues and chemical supply companies' chemical brochures for warnings and handling procedures for the various chemicals used throughout the plant.

9.6 Heat

The hazard of heat is often overlooked and not included in the list of main hazards, yet many injuries occur that are heat related.

Personal protective equipment such as safety glasses, hard hat, ear muffs, and gloves will ensure minimum protection if worn. Most importantly, common sense and safety awareness is required.

There are many forms of exposure to heat hazards. A few typical ones are listed below:

- Work near hot surfaces such as exposed process and tracing lines, hot valves, etc.
- Work involving steam hose usage.
- Furance front radiant heat.
- Work around fired heaters.
- Insulation exchanger flanges, etc.
- Work in areas where spills or venting may occur.

Each situation requires safe thinking. For example, the position an operator takes when blowing down hot fluids, the wearing of leather gloves and the wearing of proper footwear

when hot spills can occur. In each of these situations and in many others, the most effective safety measure is the common sense approach; be aware of the hazard and act accordingly.

10.0 Instrumentation/Controls Shutdown

The following are operating parameters and instructions for system/equipment control. Controls are listed and reference is made to P & ID 080-D3001 Rev. 4

The system is designed for DSS Canment Heavy Oil Mine-Plant at Devon, Alberta. The basis of design of this system is:

- Flexibility to incorporate ongoing modification with minimal effort.
- Allow massive storage of data (Scan rates of less than 3 seconds).
- Make all data available to research personnel for detailed analysis.

10.1 Basic Control System

The pilot project is automated and provided with sufficient control, alarm and shutdown devices to ensure safe operations.

Important process variables are controlled, recorded and indicated locally.

A control panel, located in the MCC "Building" contains the following instruments and devices:

- Alarm/Shutdown annunciator
- Acknowledge and test switches
- Various flow indications (FQI readouts)
- Instrument air pressure indication
- ESD switch

The annunciator is of the "First Out" sequence type (flashing light for fist variable) and subsequent variables are indicated by a steady light. Electric horn give audible warning of process upsets. These operate in conjunction with the annunciators.

Red flashing lights indicate a shutdown function in all cases.

In addition to electric horns, a revolving red and amber light on the side of the MCC Building is activated by a

malfunction indication on the annunciator (red meaning shutdown and amber indicating upset condition).

The alarm must be acknowledged on the panel to reset horns and lights.

The ESD switch on the panel allows the plant to be shutdown safely in case of an emergency.

10.2 System Set-up

The system is designed with 3 operating modes:

10.2.1 Calibration mode communicates with the intelligent field devices to allow research personnel to modify parameters, troubleshoot system, etc.

10.2.2 Monitor mode allows the research personnel to set the time frame, scan rate, etc., of the system prior to starting an experiment.

10.2.3 Engineering mode translates the stored data file into the "Smart" Spreadsheet language for detail analysis of experiment data.

10.3 Using the System

Upon power-up of the computer, a menu indicating the key strokes required to enter any of the three modes above. After selection, the selected program is automatically loaded and ready for use.

10.3.1 The calibration program is menu driven, thus it is very simple to use. An electrical description of the operating functions can be found in Section 10.3 of the job manual "Manager 6600".

10.3.2 The Monitor mode is also menu driven but is less user friendly than the calibration mode. The important items not clearly defined for the program are:

a) The setup file for this application is "CANMET"

b) After completion of the batch run, you must execute the following commands to return to the Main Screen:

1) SYSTEM
2) CD C"/
3) AUTOEXEC

10.3.3 The engineering mode uses the Smart spreadsheet for detailed analysis. The Smart Instructions are listed in the Smart System Manuals.

10.4 Software Packages

Software Packages suggested with System are:

10.4.1 Innovative Software :

a) Smart System Manual
b) Smart Spreadsheet with Graphic Manuals.

- IBM DOS Manual Version 3.2
- IBM BASIC Manual Version 3.0
- IBM Installation and Setup Manual for Personal Computer A.T.
- IBM Guide to Operations Manual for Personal Computer A.T.
- Metrabyte DASH-16/16F Manual.
- Moore Menu 352 configuration Handbook (2 copies) Drawings and Documentation

10.4.2 Objective of the software is to:

- Test non-newtoniancy of a Produced Oil.
- Measure the apparent viscosity of a Produced Oil.
- Correlate shear rate - shear stress ratio.
- Determine flow transition/stability.

Outline of the program:

Converting DP from inches of H_2O to g/cm^2
1 inches of H_2O =

$$0.36\ lb/in^2 \times 453.6\ g/lb \times \frac{1\ in^2}{6.4516\ cm^2}$$

$$= 2.531\ g/cm^2$$

- The 0-10 inch range on the transmitter should equal 0 - 25.31 g/cm². This is to be changed in the monitor software.

- Equivalent length of test loop = 1,710.5 cm

- Calculating

  LST = Log (DP r/L)
  LST = Log (.2408 x DP)
  DP = g/cm²
  LST = Log sheer stress
  LSR = (8 Qr)
  Q = cm³/sec
  5R = Log sheer rate
  LSR = 10.354Q

- Using Smart execute file: Testloop

- Starting at R1:C1 enter 5 values of DP read from the test data. These values should cover a span of at least 25%.

- Starting at R1:C2 enter 5 values of the flow corresponding to the selected DP.

- When selecting data follow original design prepared by Dr. F. Wu.

Press F5 to calculate LST and LSR.

On command list 2:

Graphics SELECT

Generate SELECT

Loop PREDEFINED SELECT

The above will generate an XY graph which will determine viscosity factors.

10.5 Drawings and Documentation

10.5.1 ITT Barton DMt Outline Dimensions

10.5.2 ITT Barton DMt Panel Wiring Diagrams

10.5.3 ITT Barton DMt Panel Connection Diagrams

10.5.4 Delta Projects Inc. drawing #B87120-E6 Rev. 0 Fibre-Optics Connection Diagram

10.5.5 Delta Projects Inc. Drawing #B87120-E6 Rev. 0 control panel support and Connection Diagrams.

10.5.6 Micro 352 Installation and Service Instruction.

10.5.7 Micro 352 Configuration Documentation Booklet.

10.6 Tag List for Instruments

FT-011 Diluent Injection P-4 Flow Rate
FT-002 Produced Oil from Tank T2
FT-012 Demulsifier Injection P-5 Flow Rate
FT-001 Feed from T1
PT-021 Electrostatic Treater V-2 Pressure
FT-302 Produced Oil from Evaporator
PDT-020 Rheological Test Loop Diff. Press
FQT-003 Free Water K.O. Inlet V-1 Flow Total
FT-601 Recovered Diluent from Coaleser Outlet Flow
FQT-004 Free Water K.O. V-1 Water Flow Total
FT-602 Water from Diluent Coaleser Outlet Flow
FQT-005 Free Water K.O. V-1 Oil Outlet Flow Total
FT-302 Heavy Oil from HP Pump Flow
DT-093 Free Water K.O. V-1 Oil Outlet Density
FQT-006 Electrostatic Treater V-2 Oil Outlet Flow Total
FQT-007 Electrostatic Treater V-2 Water Outlet Flow Total
PT-201 Heavy Oil Evaporator V-3 Pressure (on top)
BSW-097 Produces Oil Storage Tank Inlet
TI-042 Rheological Test Loop Temp.
TI-040 Produced Oil from Storage T-2 Temp.
TI-301 Heavy Oil from HP Pump Temp.
TI-201A Heavy Oil Evaporator Temp. Profile (bottom)
TI-201B Heavy Oil Evaporator Temp. Profile
TI-201C Heavy Oil Prefill
TI-043 Electrostatic Treater T-2 Temp.

Instrument Index - Item 53

1. Magnetic Flowmeter

(Fisher & Porter (Canada) Ltd.)

Mini-Mag Magnetic Flowmeter

Model:	IOD1475
Size:	1 inch
Liner:	Tefzel, Electrode: Zirconium
Output:	4-20 mA
Required Power:	120 Vac, 60 Hz
Flow rate:	0-50 L/min

Universal Indicating Totalizer

Model:	52FT100
Input:	4-20 mA
Required Power:	None

LCD flow rate and total indicator
Direct reading rate display in engineering units, direct reading totalizer in engineering units.

2. In-line Turbine Flowmeter

(Pembina Controls Ltd.)

Camco 3/4 inch, 150 lb. R.F., C.S. flanged liquid flow industrial grade turbine meter with flow rate 0-29 USGPM repeatability: 0.05% from any point in the linear range.

Bearing & Shaft - Tungsten Carbide
Rofor - 17.4 PHSS, Stator - 316 SS
Model: 4130-000-23210

Magnetic Pickup #3030 P/N T6022-011-00000

Camco Big Tex II Turbine meter readout.
Model: T6092-000-20001
c/w 15 ft. Magnetic pickup cable assy, P/N T1332-000-00015
Optional 4-20 mA Flow rate output

3. Basic Solids & Water Meter (BS & W)

(Pembina Controls Ltd.)

- Hydril Hyflo Series 4200 oil & water monitoring probe & sensor
Model: 4200-02=30-1-07-1-10 P/N 190-1431-000/2111401 2" Dia. x 17" long
Raised Face Flanges 150 ANSI 0-25% BS & W, 0-5 mA output Carbon Steel, Scli. 40
High temperature (150-380°F)
Calibration Card 0-25% P/N 100-4004-007 S/N: 8240082

Probe S/N: C4956
Sensor Card S/N: #8305061

- Hydril Hyflo Series 4200 oil & water monitoring probe & sensor
Model: 4202-03-25-1, P/N 190-1480-000/2204-01
110 VAC Input Power
0-25% BS & W Multi Scale Meter Indicator

4. In-line pH Meter

(GS Hitech Controls)

TBI Model 551-4-2-4-0-1 pH probe
- High temperature (0-120°C)
- High pH (2-14 pH)
- Integral temperature compensation
- Teflon recessed liquid junction
- C/W epoxy twist-rock adaptor - 1" NPT

TBI Model 540-0-1-2-3-0 pH indicator
- Digital LCD display
- 115 VAC, 50-60 Hz Power
- 4-20 mA isolated output
- CSA approved
- C/W pipe mounting kit
- dual alarms

5. Denisty Meter

(Rosemount Instruments Ltd.)

In-line 3660 KAYRAY complete with the following:
7063 P = Source housing
7700-500 = 500 mci source
7012UL = Detector
GDT-IOAD = Transmitter
7661 = Horization transmitter mounting bracket
7612-2 = 2" Z pipe saddle W/lead collar
7628-2 = 2" glass lined Z pipe
7649-25 = 25 ft. of signal cable
Calib: 0.99 to 0.89 sg
AEPB = Alberta Electrical Protection Branch approval

Instrumentation & Gauges on the major equipment:

1) F.W.K.O (Free Water Knockout Vessel)

1 - 2" consolidated relief valve set at 75
1 - 1 1/2 NPT Roots 8C125 gas meter
1 - 2" Kimray 227 FGT BPS back pressure valve
3 - 2" Worcester Series 44 ball valves
2 - 2" Fisher 2901-244V level controls with SS floats
2 - 2" Fisher 126 PQ control Valve W/ " Taper Trim
2 - 1/4" Fisher 67 AFR regulators 30-60 #
1 - 1/2x3" thermometer 50-500°F W/6" stem & TW
1 - 14-R-20 Jerguson Gauge Column
1 - 14-T-20 Jerguson Gauge column
2 - Sets 146 Jerguson Gauge Valves
3 - 1" Flotrac Model 380 Liquid Meters
3 - 1/2x4 1 1/2" pressure Gauges 0-160 #

2. D.P.E.T. (Dual Polarity Electrostatic Treater)

1 - transformer 2-kVA 480 Volt Supply VAC primary single phase, 9000/12,500/16,500/23,000 VDC Secondary

3 - chromalox heater model NWHO-8L-2435WSER 480 volt, 3 phase, 20 kW output, incoloy shielded, temperature controller, high temperature shutdown, C/W thermowells. Max operating temperature 300 °F. Max operating pressure 75 psi.

1 - Mayno Pump IL3 1/2 Hp, 1200 rpm. Motor 480 volt. Temperature 300 °F Exp-proof.

1 - Combination circuit breaker & manual switch, C/W exp-proof housing & locking device, single phase, 2-pole, GOHz. Transformer is 2 kVA, 480 volt supply 5 Amp. breaker.

1 - Voltmeter Weston Model 304 100/500 VAC

2 - ACME Entrance Bushings S-75

2 - C.E. Invalco turbine meter WCC30750 1.3-13 gpm, 300 °F design temperature, C/W model 3115 Flow totalizer (3/4" meter gpm readout), high temperature magnetic pick C/W 10 ft. of cable

1 - Electrical light globe glass crouse-hinds V75

1 - Electrical light socket crouse-hinds V275

1 - Electrical light guards crouse-hinds V911

1 - Ammeter model 04210 Simpson Instrument 0-50 Scale 2-1/2" Dial

1 - Electrical exp/proof crouse-hinds EMH521-20200

1 - Fisher 98H 1" NPT Back pressure controller, design temperature 300 °F.

1 - Vlco valve diaph. DSG-160-418 1/4" Taper

1 - Drexelbrook 506-6900-91 L.L.C 1" NPT

1 - Valve Gate 1" Figure 488

2 - Needle Valve 1/2" 10000 # angle

2 - Relief VLV Baird 1" Model 7100-1-GHP (75 psi)

10 - 1" 1500# NPT ball valve watts

1 - 1-1/2" 1500# NPT ball valve watts

9 - 1/2" 1500# NPT ball valve watts

2 - Solenoid VLV ASCO 1/4" Model 832058

2 - Therm .5"x5" W/12" STEM -20C-120C

2 - Thermowell .5"x5"x12"

4 - Thermometer 5" Dial Face -10-110°C C/W 76 mm Stem 1/2" NPT

3 - Thermowell .5"x.75"x4"

1 - Thermowell 1"x1/2" NPT w/76 mm Stem

2 - Press GA 4.5 100# 700 KPa 1/2" BTM/CON

1 - Check Valve 1" 1500# NPT

1 - Valve Mini 1/4" SCRD Anderson Greenwood

1 - Fisher Reg 67 FR 1/4" 5-35 Psi STD Trim

3. Portable Mixers

MITSUBISHI AC variable frequency controller.

- overload preset at 150% of full load
- isolated 4-20 mA control input
- isolated 4-20 mA monitor input suitable for 2/60/230 V power including all local approval

4. Positive Displacement Pumps

TOSHIBA Model VT130G1-2035, 3Hp, 230 volt input, variable frequency output drive C/W digital frequency meter with fault indication.

1.0 Start-up Safety

Fact - You can't avoid the first start-up or shutdown, so you best BE PREPARED.

Be prepared for hazards you don't encounter in a normally operating plant. Be prepared to eliminate hazards on the spot, or if you can't eliminate them, minimize them.

Be prepared by anticipating and knowing the effects of your actions by insisting on good housekeeping and by using personal protective gear where required and knowing how to use safety equipment.

Be aware of the actions of others so that they too may be safe.

Don't be careless, bear in mind that the best safety device is a carefully operator with an intimate knowledge of the equipment under his charge.

Operators should be familiar with Alberta "Occupational Health and Safety Regulations" and must comply with these regulations.

Personal Protection

Hazards may be encountered when performing any of these activities:

Air Blowing

When new lines are blown clean with compressed air, ensure that:

a. Personnel in blow off areas are informed and keep away from blow points.

b. Ensure people are informed of your activities.

c. Discharge flushing material to areas where it will not create a slipping or other hazard.

Leak Checking

a. Before starting, check equipment thoroughly for loose connections, this will eliminate major leaks.

b. Be thorough, an overlooked leak at this stage may develop into a serious hazard later.

Charging Chemicals

a. Thoroughly check equipment into which chemical is to be charged for loose connections and open valves.

b. Wear protective gear - goggles, etc.

c. Keep others away.

d. If chemicals are unloaded from trucks, check unloading connections for tightness and ensure grounding wire is connected.

e. Ensure vent is open on vessel into which chemical is unloaded.

Purging

One of the more hazardous tasks in commissioning is the removal of air from equipment before gas is charged. This is called PURGING. The following are specific safety precautions for purging:

- Smoking must be prohibited in the plant before purging commences.

- All sources of ignition such as open fired, fired heaters, welding and vehicles must either not be allowed or must be tightly controlled (hot work permits, explosive meter tests, etc.).

- All personnel in the area must be informed and warned not to cause sparks by using tools with caution, not dropping tools, not wearing boots with steel nails or kick plates.

- Purging must be done at a slow rate to keep gas velocities at a low level - DON'T HURRY.

- The flare must be OUT when purging.

- Initial purging must be done at atmospheric pressure.

- Purge each line separately and keep track of purged systems/lines by marking up a flowsheet in color.

- Purge to atmosphere outside buildings and confined spaces. Use hoses if necessary to lead vented gas outside.

- Know how to use an Explosive Meter. Use the 100% Gas Scale to check purging results. Use the L.E.L. scale to check areas for explosive mixtures.

- Drain low points frequently during and after purging to remove water.

It is absolutely necessary that equipment is properly purged before it can safely but put into operation.

Purging air out of lines and vessels with sweet gas can be done safely if those involved understand the basic hazard. Enforce safety rules and rigidly adhere to the safe work procedures given.

The hazard can be explained as follows:

When hydrocarbon gas and air are mixed, an explosive mixture may be created if the gas/air ratio falls within the explosive limits of the gas.

The explosive limits of natural gas are quite narrow. Depending on the composition of the gas, they vary between 4 and 15%. If such a mixture is created and a source of ignition is present, an explosion or fire may occur.

By adhering to safe purging practices, sources of ignition are kept away.

Sources of ignition may be external such as open fires, welding sparks, running engines or people smoking.

Internal sources of ignition may be caused by one or more of the following:

- A sudden pressure rise (by heat of compression) to the point of ignition. This can occur if the purge gas is turned into the system too rapidly.

- Small objects such as gravel, rock, pieces of metal left in piping from construction, can be flung about in piping or vessels and cause a spark. Again, this can occur if gas is turned on too fast.

- A falling liquid, such as water left in a line from hydrstatic testing, when pushed into a vessel by too large a volume of gas at too much pressure, could generate a static electrical discharge and cause a spark.

These possible sources of ignition can be avoided by simply introducing the purge gas AT A VERY SLOW RATE and controlling the pressure on the system being purged.

Never allow the pressure to exceed 40 kPa until all purging is complete.

Safe practice is to slowly flow purge first until all air is removed as indicated by a tested and calibrated instrument for gas analysis. Then follow up with three pressure purges. This ensures removal of air from dead ends and aids in the removal of water if low point drains are blown during purging and pressuring. Also, leak checking can be combined with pressure purging.

2.0 Plant Hazards

The following is a discussion of hazards to which plant personnel may be exposed to from time to time.

Such hazards are:

a. Electrical

Electric power in the plant is used in a conventional as well as in an unconventional way. The unconventional way is the heating of E Wells with electric power of voltages up to 4160 volts.

The equipment used for this application of electric power has been specifically designed and built for this service. Safety devices have been installed which will effectively protect personnel from electrical hazards by causing trips before a hazardous situation occurs.

But because of the newness of this application of electricity, the exposure of plant personnel to potential electrical hazards may be greater and therefore requires more discussion.

There are several terms which plant personnel must fully understand.

Current may be thought of as the total volume of water flowing past a certain point in a given length of time. Electric current is measured in amperes, which is a very large quantity in relation to its effects on the human body. The measurement used in relation to electric shock, therefore, is the milliampere (0.001 ampere).

Voltage may be thought of as pressure in a pipeline. It is measured in volts.

Resistance is any condition which retards flow. It is measured in ohms.

Current flow is the factor that causes injury in electric shock. In other words, the severity of electric shock is determined by the amount of current flow through the body. In general, an alternating current of 100 milliamps at a frequency of 60 cycles per second (60 Hz) may be fatal if it passes through the vital organs. Similarly, it is estimated that a value of 60 milliamps is the average current at which a person can still release himself from an object held by the hand.

Effects of Electric Current on Man

Effect	Current in Milliamps 60 Hz.
Slight sensation on hand	0.4
Shock, not painful, muscular control not lost	1.8
Painful shock, let-go threshold	16
Shock, painful and severe, muscular contractions, breathing difficult	23
Shock, possible ventricular fibrilation from 3 second shocks	100

Human Resistance to Electric Current

Body Area	Resistance (ohms)
Dry Skin	100,000 to 600,000
Wet Skin	1000
Internal Body-Hand to Foot	400 to 600
Ear to Ear	(About) 100

Because current flow depends on voltage and resistance, these factors are important. Other factors affecting the amount of damage done are the parts of the body involved, the duration of the current flow through the body and the frequency.

Resistance to flow is mainly found in the skin surface. Dry skin has a fairly high resistance but a sharp decrease in resistance takes place when the skin is moist. Once the skin resistance is broken down, the current flows readily through the blood and body tissue.

Whatever protection is offered by the skin resistance decreases rapidly with increase in voltage. High voltage alternating current of 60 Hz causes violent muscular contractions, often so severe that the victim is thrown clear of the circuit.

Although the low voltage also results in muscular contraction, the effect is not so violent. The fact, however, that low voltage often prevents the victim from freeing himself from the circuit, makes exposure to it dangerous.

Death or injury by electric shock may result from the following effects of current on the body.

- Contraction of the chest muscles which may interfere with breathing to such an extent that death will result from asphyxiation when exposure is prolonged.

- Temporary paralysis of the nerve centre which may result in failure of respiration, a condition which often continues until long after the victim is freed from the circuit.

- Interferency with normal rhythm of the heart, causing ventricular fibrilation. In this condition, the fibres of the heart muscle, instead of contracting in a co-ordinated manner (which causes the heart to act as a pump), contract separately and different times. Blood circulation ceases and (unless proper resuscitation efforts are made) death ensues. The heart can not spontaneously recover from this condition.

- Suspension of heart action by muscular contraction (on contract with heavy current). In this case the heart may resume its normal rhythm when the victim is freed from the current.

- Hemmorages and destruction of tissues, nerves and muscles from heat due to heavy current along the path of the electric circuit through the body.

In general, the longer the current flows through the body, the more serious may be the result. Considerable current is likely to flow from high voltage sources and only very short exposure can be tolerated.

Another type of injury is burns from electric flashes. Such burns are usually deep and slow to heal and may involve large areas of the body.

Even persons at a relatively good distance from the arc may receive eye burns.

Statistics indicate that only a small percentage of those who recover from electric shock show permanent disability. In most cases the victim may be saved by prompt application of artificial resuscitation since a common result in electrical accidents is

failure of that part of the nervous system which controls breathing.

It is therefore essential that all plant personnel be instructed in mouth to mouth or other effective means of resuscitation. It is also advisable to have a person on site at all times who has received competent instructions (under medical supervision) in external cardiac compression. This technique, applied in conjunction with respiratory resuscitation, is used in electric shock cases involving ventricular fibrilation.

Resuscitation techniques should be immediately applied to a victim of electric shock and should be continued until he revives or until death is diagnosed by a physician.

In addition, plant personnel should be trained in rescue procedures and specific safety rules. Safe work procedures should be developed and implemented.

Such safety rules and procedures should include the following:

- Don't touch or grab a person who is "hung up" (in contact with live lines or equipment).
- Know locations of power shutoff devices.
- When entering well area, ensure power is off, locked out and tagged out.
- A permit system to carry out all work under tight control.

b. Chemicals

The more hazardous chemicals in the plant are:

- Caustic Soda

Hazard

- This material, also called sodium hydroxide, has a very corrosive action on body tissue in both solid and solution form.
- Inhalation of dust or concentrated mist can damage the respiratory tract or cause severe irritation.
- Caustic soda will react with water to produce heat will attack tissue and cause severe burns to skin and eyes.

Protection

- Wear approved fully protective gear when working with caustic soda, such as:
  - Chemical Gloves
  - Neoprene Boots
  - Chemical Hood
  - Goggles
- Know the location of safety showers and eyewash fountains.
- When spills occur ventilate and flush with large amounts of water. Do not step into spilled material. It is very slippery.
- Take care when mixing caustic soda with water - boiling and splashing will occur.
- Know proper first aid procedures.

First Aid

- START FIRST AID AT ONCE - Speed in removing this material from the body is of prime importance.
- Wash material off the person with plenty of running water, use safety shower. Remove contaminated clothing while under shower.
- Shower for at least 15 minutes, longer if possible - DO NOT USE SOAP.
- In case of eye contact wash eyes for at least 15 minutes. If pain persists, for another 15 minute period. Roll eyes in a circular motion to ensure contact with water with all tissues of eye and lid.

Potassium Permanganate

- Toxicity

  Potassium permanganate dust is irritating to the skin, eyes, nose and throat because of its strong oxidizing properties.

- Fire Hazard

Potassium permanganate is a very powerful oxidizing agent, and hence the fire hazard is moderate by chemical reaction. It is explosive in contact with sulphuric acid or hydrogen peroxide.

Potassium permanganate is spontaneously flammable on contact with glycerine and ethylene glycol.

- Storage

Potassium permanganate must be stored away from all oils and acids especially Ethylene Glycol and Sulphuric Acid. Storage facilities must be kept separate by means of a storage shed, bunker, or cabinet.

The area must be clearly marked with an appropriate sign (STORAGE AREA FOR POTASSIUM PERMANGANATE ONLY".

- Protection

When handling potassium permanganate, wear the following protective equipment:

- Chemical Gloves
- Safety Goggles
- Dust Mask

Wash the affected area of skin with water for 2 or 3 minutes.

- Hydrogen Sulphide (H_2S)

H_2S may be released from the recovered bitumen and may be present anywhere in the plant, particularly in process areas.

- Hazard

H_2S is a highly toxic, colorless gas, heavier than air, with the odor of rotten eggs. It burns with a blue flame and produces Sulphur Dioxide (SO_2), a very irritating gas with a pungent odor.

H_2S forms explosive mixtures with air, the lower explosive limit being 4.3% and the upper explosive limit 46.0%. It is soluble in water (and oil) but becomes less soluble at high temperatures.

Prolonged exposure to low concentrations will dull the sense of smell. This can be fatal to those who think they can detect a dangerous concentration by the offensive odor.

In low concentrations H_2S irritates eyes, throat and respiratory system. When high concentrations are present, death, due to lung paralysis may occur before the odor is detected.

Toxicity of various concentrations:

1 ppm (.0001%)	Can smell
10 ppm (.001%)	Allowable for 8 hour exposure
100 ppm (.01%)	Kills smell in 3 - 5 minutes. May burn eyes and throat.
200 ppm (.02%)	Kills smell rapidly, burns eyes and throat
500 ppm (.05%)	Respiratory disturbances in 2-15 minutes. Artificial resuscitation needed.
700 ppm (.07%)	Quick unconsciousness breathing stops, immediate artificial resuscitation needed.
1000 ppm (.1%)	Unconsciousness at once, permanent brain damage unless rescued promptly.

From this it is obvious that the wearing of protective breathing equipment is a MUST in any H_2S concentration.

3.0 Detection and Protection

Of the portable detectors available, two of the most commonly used are:

- LEAD ACETATE PAPER OR AMPOULES
- AIR SAMPLING GAS DETECTOR TUBES

Lead acetate devices only indicate the presence of H_2S and are not to be used to measure H_2S concentrations. H_2S detectors and tubes are used to measure concentrations and are accurate if the person doing the testing is trained in their use.

Breathing protection must be worn whenever H_2S is encountered or suspected in an area. A mechanical resuscitator should be made available at the plant. Plant personnel must be trained in the use of breathing equipment, in performing rescues and in First-Aid. Frequent rescue practices should be carried out to maintain a high standard of training.

Rescue

If one finds a person overcome with H_2S, the natural and instinctive thing to do is to rush in and help. Personnel dealing with H_2S must be trained and must train themselves to oppose this instinctive action.

The sequence of rescuing must always be:

FIRST - PROTECT YOURSELF
This ensures that there will not be two victims.

SECOND - CALL FOR HELP, SOUND ALARM
This ensures that you won't be left alone with the victim, that someone calls a doctor and gets a rescue vehicle ready, that someone will come to help you and/or fix the leak.

THIRD - PROCEED WITH THE RESCUE

Basic Rescue Procedure

- Remove victim to fresh air and apply artificial resuscitation OR - if equipped with mechanical resuscitator and victim is difficult to move - apply mechanical resuscitation on the spot.
- Get a doctor or get victim to a doctor.
- Keep victim warm.
- Do not give an unconscious person anything by mouth.

- Do not leave victim unattended even after he regains consciousness.

4.0 Commissioning and Start-up

Introduction

This section covers the activities required for the initial commissioning and start-up of the new facility. The hazards involved are explained at the outset, additional and specific safety precautions are given where a potential hazardous task is to be carried out.

The pre-start-up work is divided into easily manageable work packages or procedures for one or two operators.

The sequence and estimated duration of commissioning activities is indicated on the Commissioning Schedule on the next page. This summary sheet also shows parallel and sequentional operations and can be used to mark progress made.

Operators are cautioned to follow procedures in detail. Deviations must be authorized by the supervisor in charge of these operations and by the Delta Start-up Engineer.

- Overall Plant Check-Out

  For initial start-up, the equipment must be thoroughly checked and prepared for operability. Thorough and complete preparations will help to ensure a successful start-up and satisfactory operations.

  The following is a recommended list of items constituting preparation for operation. While not all of these will necessarily be conducted by operating personnel, it is suggested that the operating personnel assure that the preparations have been made.

  This overall check out must be carried out before any hands-on work can begin.

- Procedure for Check-out

  It is recommended that experienced operating personnel check out assigned sections of the plant and indicate checked sections in colour on the master flow sheets provided for this purpose.

a. Vessels, Towers, Tanks

- Check that external and internal components are installed as per flow sheet and drawings and that vessel is internally clean.
- Check that vessel is closed or otherwise prepared for start-up as required.
- Check vessel is adequately winterized (if required).

b. Heaters

- Ensure that vendor recommended Pre-Start-up Inspection has been carried out or carry out as required using vendor supplied inspection sheet.
- Check that external components and attachments are installed and conform to the flowsheet.
- Mark completeness of check on flowsheet.

c. Pumps and Drivers

- Check Drivers

Motors

- Visual check for damage.
- Ground Connection.
- Lubrication - Note: do not lubricate unless vendor's instructions specifically request it.

- Centrifugal Pumps

- Visual check for damage, completeness and conformity to flowsheet.
- Drains, plugs.
- Piping connections, attachments
- Check valves(s) permitting flow.
- Mechanical seal/flush lines correctly installed as per specifications.
- Lubrication/coupling.
- Suction screens.
- Winterization (if necessary).

- Positive Displacement Pumps

- Visual check for damage, completeness and conformity to flowsheet.
- Drains, plugs.
- Piping connections, attachments.
- Check valve permitting flow.

- Packings loose
- Lubrication.
- Suction screens.

d. Heat Exchangers

- Check connections are as per flowsheet and mechanical drawings.
- Visually check for insulation and other damage.
- Check winterization is adequate.

e. Aerial Coolers

- Visually check for damage.
- Check connections are as per flowsheet and mechanical drawings.
- Check louvre movement.
- Check winterization is adequate.

- Check lubrication on motors and gear boxes.

f. Piping

Piping will be checked in systems or sections. Each checked section will be colour coded on the flowsheet provided for this purpose.

The following are guide lines for checking.

- Trace pipline in assigned system or section and compare to flowsheet to ensure routing is correct.
- Ensure that such items are valves, check valves, flow elements/meters and switches are in place and are installed in proper direction.
- Check flanged joints are tight with not bolts missing or loose and with correct gaskets installed.
- Hangers and pipe supports are in place, adequate, allow movement and are not damaged.
- Insulation and tracing is complete, installed per flowsheet and not damaged.
- Check construction blinds are out, spectacle blinds as shown on flowsheet and start-up blinds as per blank list.

g. Instrumentation

Instrumentation will be checked out and documented separately by Contractor's Instrument Technicians. Operating personnel will check the following.

- Proper direction and operation of all control valves.
- Proper ranges or process indicators, i.e. pressure gauge, thermometers, etc., and condition of such items.
- PSV's and bursting discs in place where used.
- Flow meters/elements in proper direction.

h. Electrical Systems

The entire electrical system will be commissioned by the Contractor. Commissioning will include but is not limited to the following items:

- Motors and controls from MCC plus auto-restart.
- Solenoid valves, limit switches, level switches, flow transmitters.
- Fire, Gas Detectors.
- Ground Connections.
- Fans and Heaters (By Kilborn)
- Air Conditioning and Refrigeration Units (By Kilborn)
- Electrical Tracing.

The entire shutdown system will be tested before start-up and the test witnessed by plant operating personnel.

A list of instruments, devices is given in Section C.

1.0 MAJOR EQUIPMENT (Government Supplied)

1.1 F.W.K.O. (Free Water Knockout) V-1
(See Figure 1 attached)

- remove the excessive volumes of free water ahead of the treating plant
- separation of gas occurs in the upper section of the knockout
- chemical injection may be applied before, after, or both ahead and behind of the free water knockout
- feed (production fluids) encountered in the oil fields contain various water levels ranging from 0.5% - 60%
- droplets of water are in many different sizes ranging from 0.1 um up to several hundred microns (the majority are very small, 10 um and less).

Specifications

- horizontal three phase separator
- 762 mm O.D. x 1829 mm seam to seam length
- operating pressures up to 517 kPa (75 psi)
- operating temperatures up to 176°C (350°F)
- vessel internals consist of inlet flow impingement baffles, coalescing plat secion, oil flow-over wier, 304 SS wire mesh mist eliminator and liquid outlet vortex breakers
- the vessel shell is 9.5 mm (3/8") thick
- approximate weight of complete unit is 1136 kg (2500 lbs).

1.2 D.P.E.T. (Dual Polarity Electrostatic Treater V-2
(See Figure 2 & 3 attached)

- incorporates gravity with highly efficient electrostatic force field (AC & DC)
- colescence of very small water droplets
- voltage limits 12,000 - 30,000 volts
- feed to D.P.E.T. shall contain less than 8% water in the emulsion
- droplets of water in the emulsion are in many different sizes ranging from 0.1 um up to several hundred microns (the majority are very small, 10 um and less)
- produced bitumen from D.P.E.T. shall have less than 0.5% BS & W

Specifications:

- vertical vessel
- 1200 mm O.D. x 1829 mm tall
- operating pressures up to 517 kPa (75 psi)
- operating temperatures up to 150°X (302°F)
- three chromalox heaters (each unit 20 kW of heat transfer) to vary the temperature of incoming emulsion from 20°C - 150°C. The heaters are installed in series to attempt to reduce heat transfer rate to oil and thereby reduce the coking of oil onto the heating elements
- the internals of the vessel consist of electrical coalescing section (liquid packed) which has five circular grid plates
- approximate weight of complete unit is 2340 kg (5418 lbs)

1.3 Induced Gas Flotation (IGF)

- Skid mounted induced gas flotation (IGF) unit suitable to separate solids and oil from (heavy oil) produced waters containing up to 200 mg/L of oil. The unit must be capable of removing at least 90% of the influent free oil. The unit shall be a self contained unit and capable of handling a flow of up to 10 gpm of produced water with retention time of about 2 - 5 minutes.

a) Influent condition

Flowrate up to 54m^3/d (10USgpm)

Oil: Normal	200 ppm
pH:	6.3-8.5
Temperature:	Operating 25°C Design 95°C

b) Expected effluent conditions

Oil: Normal	10 ppm
Retention Time:	5 minutes

c) Equipment

Estimated weight	1360kg (3,000 lbs)
Estimated dimensions	1.67mL x 609 mm W x 1219mmH (5'6L x 24" W x 48" H)

- Depurator consists of a self-supporting 4-cell mild steel tank mounted on skids.

- Each unit contains four (4) one per cell, proprietary design mechanically powered aeration units.

- Liquid Level Controller - each unit contains one (1) Fisher Pneumatic Liquid Level Controller.

- Skimmers - one (1) stainless steel skimmer is provided with each unit and operated by one (1) 1/4 HP motor.

- VAREC Model 2010 - or equal for atmospheric vent.

FLANGES: - ASTM-A181,150# R.F. to ANSI 16.5 configuration couplings:

Nozzles:

Number	Size	Service	Rating
1	2: (50mm)	Water in	150# RFWN
1	2" (50mm)	Water out	150# RFWN
3	2" (50mm)	Oil out	150# RFWN
1	4" (102mm)	PSU/Gas out	150# RFWN
1	2" (50mm)	Drain	150# RFWN
1	2" (50mm)	Gas Inlet	150# RFWN
1	3" (75mm)	Level Control	150# RFWN

- Explosion proof electric motors are standard. The Depurator includes four 1.0 HP, 1200 rpm motors, one for each aeration mechanism. One (1) 1/4 hp motor is directly connected to a flanged gear reducer which drives the skimmer assembly. Motors are 3 phase, 60 Hz, 230/460 voltage.

1.4 Positive Displacement Pumps (3)

Blackmer Model PLW3, heavy duty rotary vane pump specifically designed to handle liquids with suspended abrasive particles. Driven by a Durodrive Mode R86DT100LS4 helical gear motors utilizing 3HP, 1800 rpm, 230/460/3/60, TEFC enclosure motors. Toshiba model VT130G1-2035, 3Hp, 230 volt input variable frequency output drive c/w digital frequency meter.

1.5 Portable Mixers (2)

Philadelphia portable helical reducer output speed 0-350 rpm. Two 10: diam. radial turbines. 3 hp, 0-1800 rpm, frame 145TC 3/60/230V TEFC A.C. Motor. Variable speed A.C. controller in Eemac 4 enclosure with isolated 4-20 mA control signal follower and isolated 4-20 mA monitor signal.

1.6 Evaporator (Dehydrator) V-3

At this point, we are in the process of getting price & availability on this item. Please include evaporator in the design of heavy oil mini-plant. The specifications for the evaporator are as follows:

Heavy oil evaporator (dehydrator) capable of breaking and removing tightly held water from various heavy oil/water emulsions from steam and fire flood production and interface emulsion from conventional treaters. The evaporator shall be a self-contained unit and capable of handling a flow of up to 70 bbl/day of product fluids. The evaporator must be capable of reducing water content of oil to less than 0.5% total BS & S and capable of recovering the circulated condensate. The evaporator shall be mounted on a skid and the total overall dimensions shall not exceed the following:

Length 5.2 m (17 feet)
Width 1.8 m (6 feet)
Height 2.1 m (7 feet)

The feed will consist of heavy oil emulsions, oil (7-15% API), water (approx 1.00 gravity) (and diluent approx. 0.8 gravity)

The evaporator shall be equipped with the following:

1. Emulsion Preheater
2. Evaporator Vessel
3. Condenser
4. Water/condensate skim vessel
5. All necessary pumps:
   a) clean oil circulation pump
   b) water disposal pump
   c) Condensate recovery pump
6. Monitoring and control system with all the necessary instrumentation. All the instrumentation shall give out 4-20mA signal to be interfaced with the computer and should also have digital displays.
7. Sufficient insulation for the evaporator.
8. The vessel shall be prepiped and ready for installaiton.

9. Evaporator shall have sludge drains.

10. The evaporator shall have a variety of sampling points.

Type of electricity available 240/460V, 60Hz, 3 phase. Please specify total power requirements. All electric motors and wiring shall meet CSA standards and be explosion proof. The material of construction shall be suitable for processing abrasive heavy oil/water emulsions, demulsifiers and some clay particles. The unit shall be complete with all appropriate gauges, controls and safety interlocks. The vessel shall be C.A. spot x-rayed, registered and inspected for use in Alberta and Saskatchewan.

1.7 On-Line Monitors

1. Magnetic Flowmeter (for produced water line)

   Its operating principle is based upon Faraday's Law of Induction which states that the voltage induced across any conductor as it moves perpendicularly through a magnetic field will be proportional to the velocity of the conductor. (Fisher & Porter Mini-Mag).

2. In-Line Turbine Flowmeter (for an emulsion line)

   The rotation of the turbine is proportional to the velocity of liquid passing through the meter. Each of the blades of a turbine rotor creates a pulse as the blades pass beneath a magnetic pickup. (Camco)

3. Liquid Level Pneumatic Controllers (in the F.W.K.O.)

   Displaces movement caused by changes in liquid level is transmitted through a flexure tube assemble to a flapper-nozzle assembly. The flapper and nozzle operate a pneumatic relay which transmits a pneumatic on-off or proportional signal to a control valve.

4. Basic Solids and Water Meter (BS&W)

   The basis for the oil and water sensor in the BS&W meter is the measurement of the capacitance of an emulsion passing through a probe placed in the fluid stream. The probe is mounted in the process stream and develops a capacitance at its electrical terminal based on the emulsions dielectric constant.

   The principle of operation is based on the differences of the dielectric constants of the fluids being measured (Hydril Hyflo series 4200).

5. O/W Level Control (in the D.P.E.T.)

   The point level controls include a rectractable sensing element and a special electronic unit. The electronic unit is precision, RF (radio frequency) relay contact closure when the interface being measured reaches a present point in the separator vessel.

   The sensor portion is mounted in the material being measured and provides a differential or RF impedance, indicating presence of water (conducting) or oil (insulating).

6. In-Line pH meter
   (TB1 model 551-4-2-9-0-1)

7. Density meter
   (Kayray density measurement system)

1.8 Tanks

There are four tanks available if required.

- one 36 inch diameter x 60 inch height
- two 30 inch diameter x 48 inch height
- one 30 inch diameter x 60 inch height

2.0 Vendor's Sketches